THE EFFECTS OF A DOUBLE BREAST MASTECTOMY ON UPPER BODY POSITION DURING SIMULATED HORSEBACK RIDING: A CASE STUDY

Jenny Burbage[1], Alex Milligan[1] and Anna Marczyk[1]

Department of Sport & Exercise Science, University of Portsmouth, Portsmouth, UK[1]

The aim of this case study was to investigate the effect of a prophylactic double breast mastectomy on upper body position during simulated horseback riding. One participant (age 41 years; height: 1.8 m; mass 90 kg), an advanced dressage rider, volunteered to be tested pre- and post-surgery (112 days apart). A digital camera (50 Hz) collected kinematic data from the upper body during simulated trotting and cantering. Trunk and elbow angles (°) and vertical displacement (mm) of the hip, shoulder, elbow and wrist were analysed over four stride cycles and compared between the pre- and post-surgery testing sessions. Results suggest that there was greater trunk and elbow extension and a decrease in vertical excursion of the upper body post-surgery, which could affect performance in dressage. This information may aid rehabilitation in horse riders who have undergone breast mastectomy surgery.

KEY WORDS: mastectomy, kinematics, horseriding, trunk, rehabilitation

INTRODUCTION: Women identified with BRCA1 or BRCA2 gene mutation have a high risk of breast cancer and are prime candidates for prophylactic bilateral total mastectomy (Cieśla & Bąk, 2012). The Research Group in Breast Health was approached by an advanced level dressage rider who was shortly due to undertake this procedure; she allowed us to undertake an investigation into the effect that this surgery may have on her riding style.

Mastectomy causes many changes in a woman's body, with consequences such as lymphatic oedemas, limitations of movement and strength affecting body posture and difficulties with postoperative scarring (Rostkowska, Bak & Samborski, 2006). The problem of changes in body posture as a result of mastectomy is not well known, despite it being an important issue for medical and psychological rehabilitation.

There has been some research investigating the effect of a breast reduction (mammoplasty) on biomechanical parameters which provides an indication of the changes that can occur when breast mass is altered. Goulart, Schütz, Detanico, Vasconcellos and dos Santos (2013) found an improvement in static balance after breast reduction surgery in women of a similar build (84 ± 19.1 kg), suggesting a positive effect of reducing breast mass on the musculoskeletal system. Similarly Glatt, Sarwer, O'Hara, Hamori, Bucky and LaRossa (1999) reported positive physical improvements after breast reduction (pre-surgery D-FF cup size), including improvements in neck, back, shoulder and breast pain, linked to better posture.

The bouncing motion of the horse during trot and canter has to be accommodated by the rider without relying on the reins to maintain balance (Terada, Clayton & Kato, 2006). Maintaining an upright posture in dressage is crucial for performance (Terada, 2000) and relies on the rectus abdominis stabilising the trunk (Terada, Mullineaux, Lanova, Kato & Clayton, 2004). As breast mastectomy surgery can weaken the trunk musculature (Cieśla & Bąk, 2012) any effect of the mastectomy surgery on the ability of this participant to adhere to an upright posture should be monitored and would provide useful feedback.

It is clear that some biomechanical changes occur as a result of breast mastectomy. A case-study approach is warranted to enable a more detailed study into physical changes as a result of mastectomy surgery, with the participant acting as their own control. Unique to this study, measuring upper body position could provide useful information about the effects of a double breast mastectomy on riding posture and performance.

METHODS: Following institutional ethical approval, the participant attended a lab session at Quob stables Equestrian Centre (Southampton, UK) four days prior to her breast surgery. A

bra fitting was undertaken to establish breast size using established best fit criteria (White & Scurr, 2012); this was measured as a 38D UK bra size, which is estimated to equate to a breast mass of 860 g (Turner & Dujon, 2005) and classing the participant as large-breasted (Gefen & Dilmoney, 2007). Her pre-surgery body mass (90 kg) and height (1.80 m) were recorded. The participant wore her normal riding trousers, a vest top and a fitted everyday underwired t-shirt bra (Marks & Spencer™).
The participant performed two basic dressage manoeuvres on a dressage simulator (Racewood, UK); a medium sitting trot (a two-beat pace) and a medium canter (a three-beat pace). These modes were chosen as they had been found to induce a large range of trunk motion in previous research (Lovett, Hodson-Tole & Nankervis, 2005). A minute of each activity was completed on the simulator after a period of familiarisation. A digital camera (Panasonic, 50 Hz) was positioned perpendicular to the participant at a distance of 3.8 m and calibrated to record data throughout the trials. Reflective markers were placed on the left side of the participant at the following anatomical landmarks: the greater trochanter (hip), acromion process (shoulder), lateral epicondyle of humerus (elbow), and the radius styloid process (wrist) (Lovett et al., 2005). Kinematic data were digitised and filtered using an optimised low pass Butterworth filter within Quintic Biomechanics (v26) software.
Marker coordinates were used to calculate the maximum and minimum heights (mm) of each marker over the four cycles. Angles (°) were determined for the participant's trunk segment and elbow joint. Trunk angle was measured relative to the vertical for a line joining the hip and shoulder; tilting the upper body backwards was assigned a positive value. Elbow angle was always positive, with smaller angles indicating greater flexion.

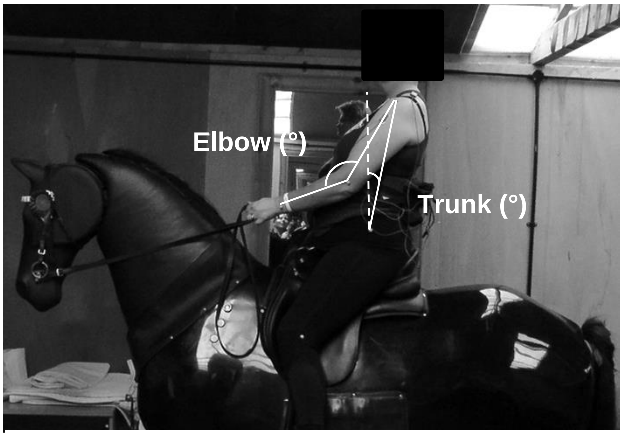

Figure 1: Lab set-up and angle conventions

Following the breast mastectomy (122 days later), the participant returned for a repeat lab session. No breast reconstruction had occurred for the participant and written consent was given by her surgeon to deem her fit to participate in post-surgery testing. Her post-surgery mass had decreased by 1 kg. The same dressage saddle and stirrup set-up were used for both testing sessions.
Four stride cycles at the end of each one minute capture were analysed and maximum, minimum and range of motion data are presented as an average of the four cycles; a single stride was determined as being the time between successive trunk minima points. The trot is classified as a symmetrical gait, data were therefore analysed for each half stride and averaged over four strides. As this is a case study no inferential statistics have been presented; within-stride coefficient of variance (CV%) has been calculated to aid interpretation of the data.

RESULTS: The range of motion (°) of the participant's trunk increased slightly post-surgery (Table 1); it is evident during the trot that there was greater trunk extension and during the canter minimum trunk extension was increased post-surgery (1.9° pre; 4.0° post). Elbow range of motion (°) was similar between pre- and post-surgery testing during trotting, although during the canter there was a reduction in range of motion by 3.7° post-surgery and the elbow is held more extended post-surgery. There is a trend of less vertical displacements of the hip, shoulder, elbow and wrist for both trotting and cantering post-surgery (Table 2). Figure 2 illustrates an example of how shoulder vertical displacement was lower post-surgery during the canter compared to pre-surgery. The within-stride CV%'s ranged from 2.4% to 6.2% for trunk and 6.4% to 15.4% for elbow range of motion. Within-stride CV%'s for the vertical displacement data were all under 10%, except for the wrist (< 14%).

Table 1: Descriptive statistics of participant's joint angles

		Minimum Extension (°)	Maximum Extension (°)	Range of Motion (°)
Trot	**Trunk**			
	Pre-surgery	7.4 (0.5)	17.3 (0.7)	9.7 (0.5)
	Post-surgery	7.3 (1.1)	19.1 (1.1)	11.8 (0.7)
	Elbow			
	Pre-surgery	118.3 (3.9)	139.4 (2.1)	22.0 (3.2)
	Post-surgery	118.4 (2.9)	142.0 (3.1)	23.7 (3.7)
Canter	**Trunk**			
	Pre-surgery	1.9 (0.6)	18.2 (1.2)	16.6 (0.9)
	Post-surgery	4.0 (0.7)	21.6 (0.5)	17.9 (0.4)
	Elbow			
	Pre-surgery	107.3 (1.0)	140.8 (2.2)	33.5 (2.1)
	Post-surgery	114.2 (2.4)	144.0 (2.6)	29.8 (3.1)

Values are mean (SD). Angle conventions are: trunk backward tilt and elbow extension positive.

Table 2: Mean (SD) vertical displacements (mm) of the participant's hip, shoulder, elbow and wrist

		Pre-surgery	Post-surgery
Trot	Hip	99.4 (0.7)	81.4 (1.6)
	Shoulder	78.3 (2.6)	74.5 (3.5)
	Elbow	105.1 (0.8)	105.1 (9.0)
	Wrist	57.9 (9.3)	51.1 (12.4)
Canter	Hip	73.7 (2.3)	64.3 (1.9)
	Shoulder	54.2 (1.9)	36.9 (2.4)
	Elbow	89.8 (4.4)	67.5 (3.4)
	Wrist	70.9 (9.6)	46.0 (6.4)

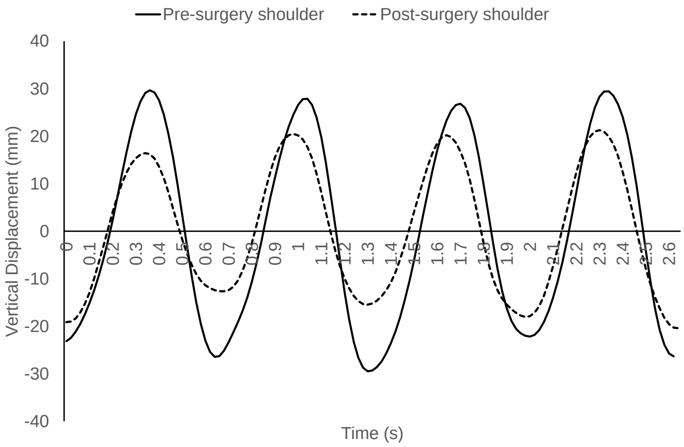

Figure 2: Vertical displacement (mm) of the shoulder during canter for pre- and post-surgery trials. The data have been normalised so the mean value across the four strides is represented as zero.

DISCUSSION: The effects of a double breast mastectomy on upper body position during simulated horseback riding were investigated for the first time in this case study. Trunk extension occurs during the impact phase of trotting and cantering to counteract the large braking forces in early stance (Terada et al., 2006), although the ideal trunk position to maintain during dressage is as close to vertical as possible. There was a trend towards greater trunk extension and ROM post-surgery (Table 1), which moves further away from the ideal vertical trunk orientation. Good posture requires the least amount of muscle activity to maintain an upright position; as breast mastectomy surgery is known to cause weakness in damaged muscles (Cieśla & Bąk, 2012) it is important that affected muscles responsible for posture are re-trained. Removal of breast mass from the anterior chest could have affected the ability of the participant to ride in a more upright position as muscles controlling posture, such as the rectus abdominis, may have been affected. Increased backwards lean could however be a motor-learning induced problem and more time may just be needed for the participant to adapt to the feel of the breast mastectomy.
There was evidence of greater elbow extension post-surgery. Although differences were relatively small (~4°) these data do support the trunk angle data, as increasing trunk extension would lead to an increase in elbow extension assuming the reins were maintained at the same distance to the rider. During the trot the participants' wrist underwent a much

smaller vertical excursion that the shoulder, hip and elbow, indicating the success of stabilising the wrist position.
Vertical excursion of the hip was greater than at the shoulder, implying absorption of some vertical motion by movement of the joints of the participant's trunk or pelvis, as found previously for experienced riders (Terada et al., 2006). Interestingly, there were substantial reductions in the vertical displacements of the hip, shoulder, elbow and wrist post-surgery, especially at the canter pace (Table 2). A reduction in bounce when counteracting the horse is beneficial in dressage, where the aim is to perform all movements without apparent effort (Terada et al., 2006). Although it is acknowledged that not separating the pelvis and trunk segments for analysis in this study is a limitation.
Utilising a dressage simulator enabled a controlled laboratory environment for this study; however these data are unable to be compared to data obtained on a horse until an investigation of the similarity between a dressage simulator and a horse is undertaken. Care must be taken to not extrapolate too much from these case-study results, although it has allowed an investigation into a novel area and has provided information for the participant concerned as to how the surgery has affected her riding performance.

CONCLUSION: This case study has demonstrated that there were some differences in upper body position during horseback riding for a participant who had undergone a bilateral breast mastectomy. Greater trunk flexion and range of motion post-surgery may be linked to muscle weakness, or could be a protective mechanism to reduce loading on muscles affected by surgery. Lower vertical excursions of the hip, shoulder, elbow and wrist post-surgery suggest a greater absorption of the trot and canter movements, which may be beneficial in dressage. This study highlights the importance of physical rehabilitation following breast mastectomy. Further analysis of muscle activity is warranted pre- to post-surgery.

REFERENCES:

Cieśla, S., & Bąk, M. (2012). The Effect of Breast Reconstruction on Maintaining a Proper Body Posture in Patients After Mastectomy. In M. Salgarello (Ed.), *Breast Reconstruction - Current Techniques* (pp. 83-102). InTech, DOI: 10.5772/29373.

Gefen, A., & Dilmoney, B. (2007). Mechanics of the normal woman's breast. *Technology and Health Care*, *15*, 259-271.

Glatt, B. S., Sarwer, D. B., O'Hara, D. E., Hamori, C., Bucky, L. P., & LaRossa, D. (1999). A retrospective study of changes in physical symptoms and body image after reduction mammaplasty. *Plastic and reconstructive surgery*, *103*(1), 76-82.

Goulart Jr, R., Schütz, G. R., Detanico, D., Vasconcellos, R. P., & dos Santos, S. G. (2013). Effects of reduction mammaplasty on the static balance and biomechanics of gait. *European Journal of Plastic Surgery*, *36*(4), 225-230.

Lovett, T., Hodson-Tole, E., & Nankervis, K. (2005). A preliminary investigation of rider position during walk, trot and canter. *Equine and Comparative Exercise Physiology*, *2*(2), 71-76.

Rostkowska, E., Bak, M., & Samborski, W. (2006). Body posture in women after mastectomy and its changes as a result of rehabilitation. *Adv Med Sci*, *51*, 287-97.

Terada, K. (2000). Comparison of head movement and EMG activity of muscles between advanced and novice horseback riders at different gaits. *Journal of Equine Science*, *11*(4), 83-90.

Terada, K., Clayton, H. M., & Kato, K. (2006). Stabilization of wrist position during horseback riding at trot. *Equine and Comparative Exercise Physiology*, *3*(4), 179-184.

Terada, K., Mullineaux, D. R., Lanovaz, J., Kato, K., & Clayton, H.M. (2004). Electromyographic analysis of the rider's muscles at trot. *Equine & Comparative Exercise Physiology*, *1*(3), 193-198.

Turner, A. J., & Dujon, D. G. (2005). Predicting cup size after reduction mammaplasty. *British Journal of Plastic Surgery*, *58*, 290-298.

White, J., & Scurr, J. (2012). Evaluation of professional bra fitting criteria for bra selection and fitting in the UK. *Ergonomics*, *55*(6), 704-711.